CNTT-E-116

BASIC ELECTRICITY AND ELECTRONICS

STUDENT HANDOUT NO. 209

SUMMARIES PROGRESS CHECKS FOR MODULES

23 LESSON 3

JUNE 1984

SUMMARY
LESSON III

Monostable Multivibrator Operation (One-Shot)

The monostable multivibrator circuit is basically used for pulse-shaping. Frequently it is known as a one-shot multivibrator. It is used in computer logic systems, electronic control systems, radar pulse-forming systems, and communication/navigation equipment. The one-shot will take a series of input trigger pulses and convert them to uniform square pulses (Figure 1).

Figure 1

The schematic for the monostable multivibrator is shown in Figure 2.

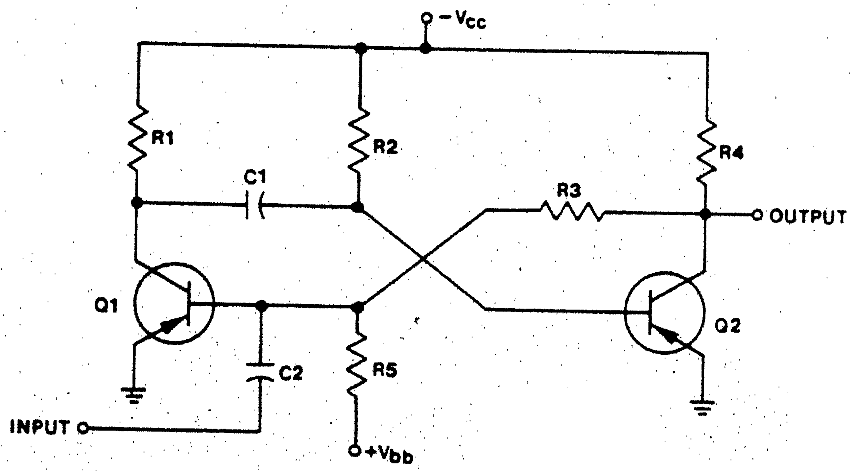


Figure 2

Immediately after the one-shot is energized, transistor Q1 will cut-off and transistor Q2 will saturate. Notice that a positive voltage ($+V_{bb}$) is applied to the base of Q1 through R5. Q2 will saturate because of the negative voltage applied to its base through R2. The circuit is now in its stable state (monostable means one stable state), as shown in Figure 3.

The output of the one-shot is taken from the collector of Q2. Since Q2 is saturated, the output voltage is approximately 0 V (Figure 3).

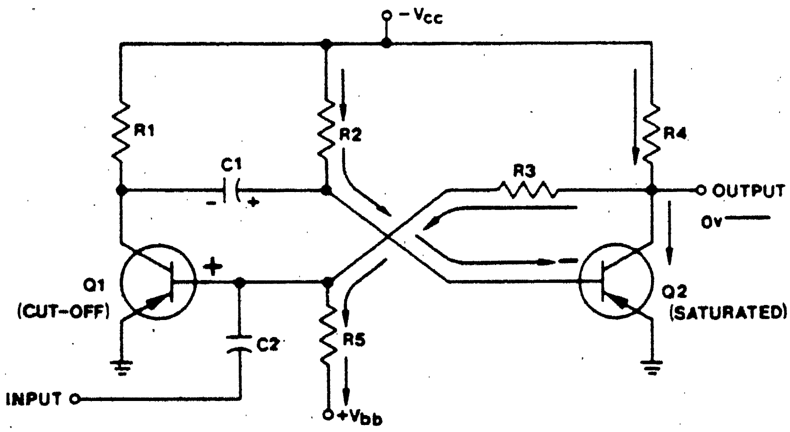


Figure 3

As long as you do not apply an input signal, the output will continuously measure zero volts.

If you apply a negative pulse at the input of the one-shot circuit in Figure 4, the base of Q1 will become more negative. Q1 will immediately saturate -- causing the voltage at it's collector to decrease to zero volts. (Remember that although we are going from a negative voltage towards positive, the most positive we can go is to zero volts. Zero volts means that there is no difference in potential, therefore, voltage at the collector of Q1 is decreasing from a negative potential to a zero potential). This decrease in potential is coupled through C1 to the base of Q2, causing zero volts to be applied to Q2's base. Q2 is now no longer forward biased and will cut off. When Q2 stops conducting, the voltage at it's collector increases to approximately $-V_{cc}$.

The output voltage is now $-V_{cc}$. The output voltage will now remain at $-V_{cc}$ for a definite period of time determined by the time constant R2 X C1. In other words, as the right side of C1 becomes more and more negative, the base of Q2 will become more and more negative.

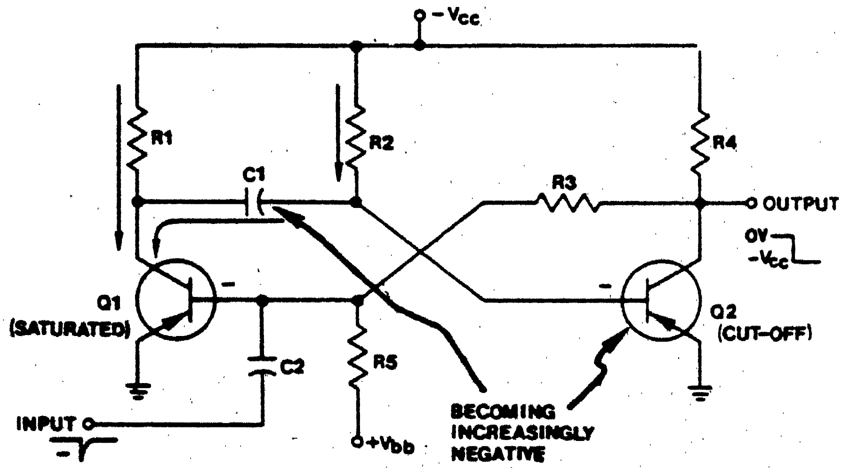


Figure 4

Eventually, the base of Q2 will become sufficiently negative to cause Q2 to conduct. Q2 will rapidly saturate, and the output voltage will decrease to 0 V. The circuit has then returned to its stable state (figure 5).

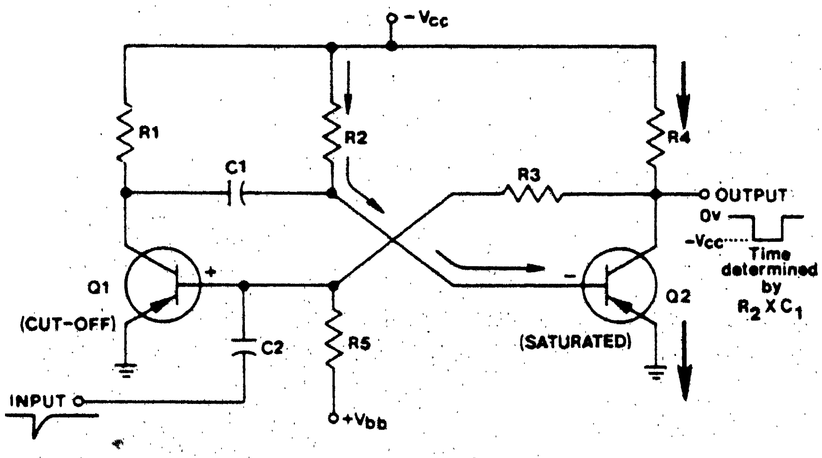


Figure 5

Each time a negative pulse is applied to the input, the one-shot output will change from 0 V to -Vcc. It will remain at -Vcc for a definite length of time, then, it will automatically return to 0 V.

AT THIS POINT, YOU MAY PROCEED TO THE JOB PROGRAM. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THIS LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR, UNTIL YOU UNDERSTAND THE MATERIAL IN THIS LESSON.

Job Program
for
Lesson III
Part 1

MULTIVIBRATORS

EQUIPMENT AND MATERIALS

1. Oscilloscope
2. Device 6F16 and Template I
3. 1X probe (3)
4. Square Wave Generator
5. "Tee" Connector
6. BNC-BNC Coaxial Cable (1)

PROCEDURES

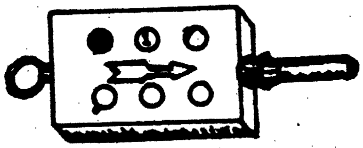
1. Using all applicable safety precautions, energize the oscilloscope, and obtain a line trace. Make the following additional settings:

   a. TIME/DIV - .2 MILLISEC/DIV
   b. VOLTS/DIV - Channel 1 : 10 VOLTS/DIV
      Channel 2 : 5 VOLTS/DIV
   c. DISPLAY MODE - CHOP
   d. Connect 1X probes to channels 1 and 2.
   e. Connect BNC "Tee" connector to the EXT Trigger input of oscilloscope.
   f. Connect BNC-BNC coaxial cable from signal generator output to one side of BNC "Tee" connector (Trigger input).
   g. Connect a 1X probe to the other side of the BNC "Tee" connector.
   h. Obtain line traces on channel 1 and 2, and let line traces as follows:
      Channel 1: +1 division above horizontal axis
      Channel 2: -1 division below horizontal axis.

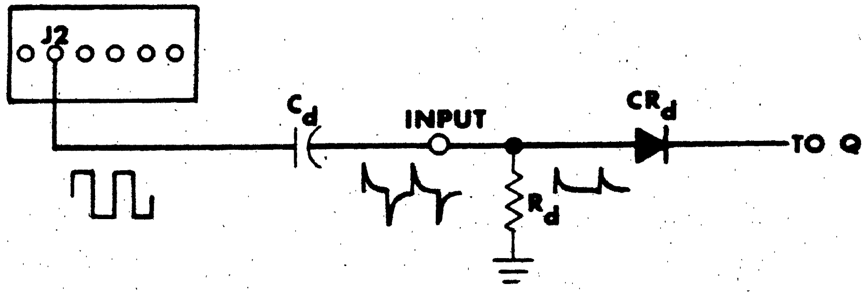
2. Using all applicable safety precautions, set up 6F16 as follows:

   a. Construct the circuit by using Template I and the required parts.
   b. Connect the channel one probe to the hole mark for the base of Q1 (towards the left of Q1).
   c. Connect the channel two probe to the "0" output (Q2 collector).
   d. Energize the 6F16 using the line cord.
   e. Connect the 1X probe from the BNC "Tee" connector to the Wave Shaping Capacitor Cd (plug side) to the circuit input located on lower left corner of template.
   f. Push EXT trigger button on oscilloscope.

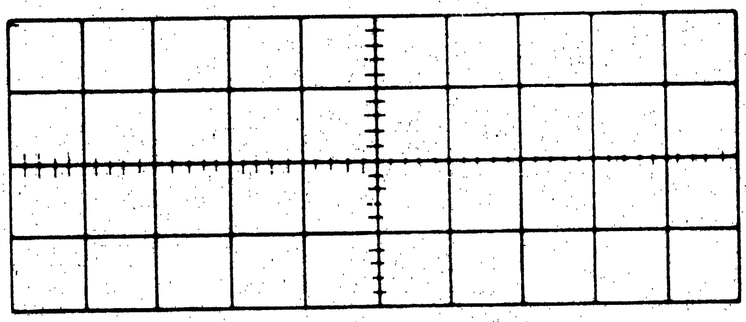
3. Set signal generator for a square wave output of 20 volts at 1 KHz.



wave shaping capacitor



6. Obtain a stable trace on the oscilloscope and draw the displayed waveforms in the space below.



7. The time that Q2 is in conduction is (greater than/less than/equal to) the time is is cutoff.

8. What is the time of the cutoff state of Q2? ________________

9. Set TIME/DIV to 50 microsec/DIV.
What is the time of the conducting state of Q2? ________________

10. The pulse width (time) of the positive going output pulse is determined by

a. the RC time of C2-R6.
b. the input frequency.
c. the RC time of C1-R7.

11. What determines how long Q2's collector will remain negative?

a. The RC time of C2-R6.
b. The input frequency.
c. The RC time of C1-R7.

12. What would happen to the output signal if capacitor C1 were changed from .01 μfd to .05 μfd?

a. The negative pulse width would increase.
b. The positive pulse width would decrease.
c. The positive pulse width would increase.
d. There would be no change in the output.

13. Remove C1 (.01 μfd) and replace with a .05 μfd capacitor. What is the pulsewidth of the positive pulse?______________________

14. When you changed the capacitance of C1, the positive pulse width (increased/decreased/remained the same).

CHECK YOUR RESPONSES TO THIS JOB PROGRAM WITH THE ANSWER SHEET. IF YOUR RESPONSES AGREE WITH THE ANSWER SHEET, YOU MAY PROCEED TO THE NEXT JOB PROGRAM. IF YOUR RESPONSES DO NOT AGREE OR IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THIS JOB PROGRAM, REVIEW THE PROCEDURES OF THIS JOB PROGRAM, ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS, OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR UNTIL YOUR RESPONSES DO AGREE.

NOTE: Review information provided in this Information Sheet prior to beginning Job Program 23-III-2.

Before you start on the Job Program, there are a few things you should know about rotary switches.

The wafer rotary switch is usually several separate switches linked (ganged) together. Figure 1 shows a typical wafer rotary switch. Notice the current path formed by the extended terminal, contact ring, wiper arm (part of the contact ring) and the short terminal touching the wiper arm.

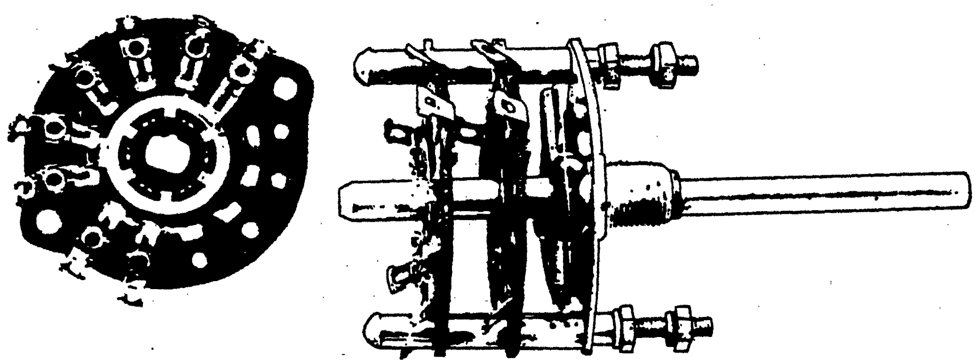


Figure 1

On most schematic diagrams the wafer rotary switch is shown in one position only. You must mentally determine the current path through the switch for any of the other positions. Figure 2 is a schematic representation of the wafer switch shown in Figure 1. The conduction path for the switch position shown is from terminal 1 through the contact ring to terminal 4. If this switch were turned two positions counterclockwise, the conduction path would now be form terminal 1 through the contact ring to terminal 2.

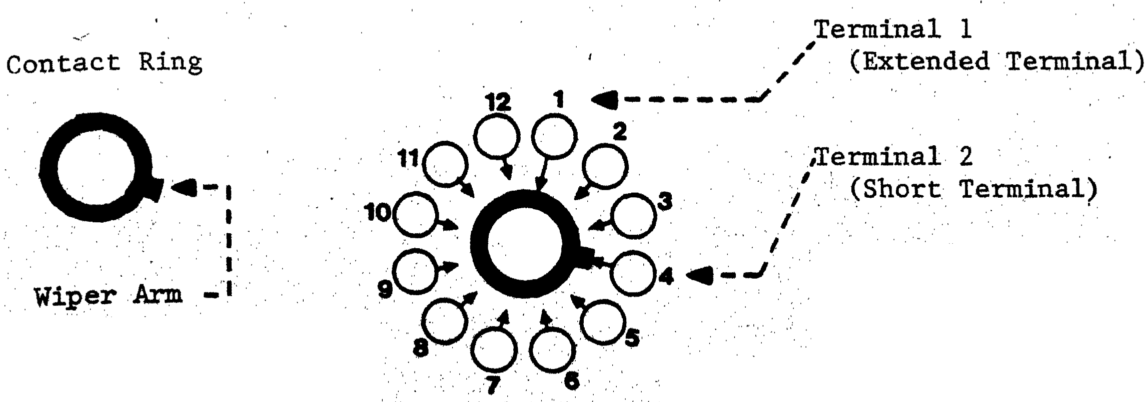


Figure 2

Figure 3 shows the schematic symbol for a slightly different type of wafer rotary switch. The basic construction of this switch is similar to the one in Figures 1 and 2. Note that the contact ring is split and there is a wiper and an extended terminal for each of the contact ring segments. There are actually two switches mounted on one wafer. Each switch operates the same as the switch in Figures 1 and 2, but there are fewer switch positions available. This switch in the position shown has a conduction path from terminal 12 through one half of the split conduction ring to terminal 11. There is also a conduction path from terminal 6 to terminal 5 through the other half of the conduction ring. If this switch were rotated two positions counterclockwise terminal 12 would be connected to terminal 9 and terminal 6 would be connected to terminal 3.

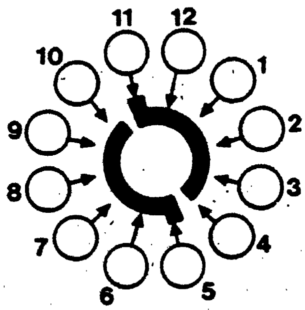


Figure 3

Figure 4 shows what a typical wafer rotary switch might look like on a schematic drawing. When these switches are shown on a schematic drawing, usually only those sections and/or positions used are shown. If there is more than one section shown for a switch, all the sections will be switched at the same time. The switch positions will be labeled on the schematic so you can tell where the wiper of the switch is actually positioned for a given switch position. For purposes of clarity on the schematic drawing, you may see an extra switch symbol with the switch positions indicated around it.

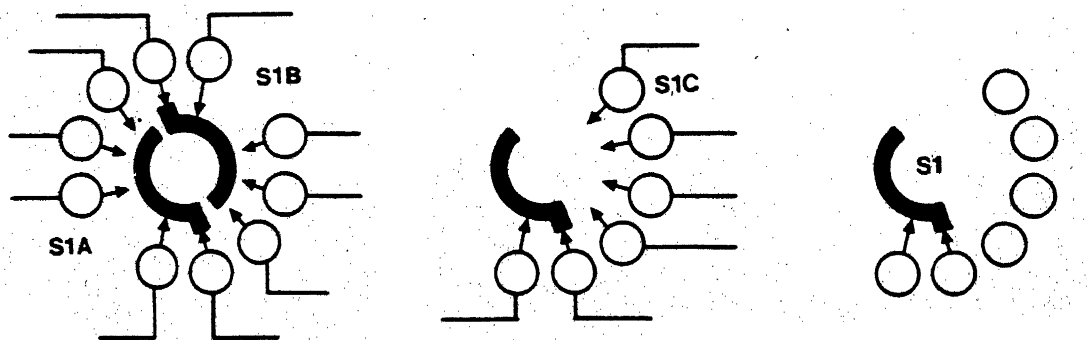


Figure 4

Now that you know how a rotary switch works, proceed to the Job Program.

JOB PROGRAM
FOR
LESSON III
PART 2

Multivibrator Systems

EQUIPMENT AND MATERIAL

1. NIDA 204 Function Generator (All good cards installed)
2. Oscilloscope
3. IX Probe (2)
4. BNC - BNC Coaxial Cable (2)
5. BNC "Tee" Connector (1)
6. Prefaulted P.C. 204-2, 204-3, 204-4 (OBTAIN IN STEP 19)
7. NIDA 204 Instruction Manual

PREOCEDURE

1. Energize and set up the oscilloscope for CHANNEL 1 operation and EXTERNAL TRIGGER mode.

   a. Using the BNC-BNC coaxial cable and the BNC "Tee" connector, connect the oscilloscope CHANNEL 1 INPUT to the EXTERNAL TRIGGER UNIT. Connect a IX Probe to the BNC "Tee" connector.

2. Set the front panel controls of the NIDA 204 Function Generator as follows:

   a. TRIGGER switch to "INT"
   b. FREQUENCY switch to "10 KHz"
   c. FREQUENCY dial to " 2 " (This setting may vary 1.5 to 3)
   d. INPUT controls - not used
   e. PULSE WIDTH switch to "10 microsecond"
   f. PULSE WIDTH dial to "8"
   g. OUTPUT SYMMETRY - not used
   h. OUTPUT LEVEL - fully clockwise
   i. FUNCTION switch to " " (single pulse)

IMPORTANT: The NIDA 204 INSTRUCTION MANUAL is a "must" in learning to troubleshoot the NIDA 204 Function Generator. If you haven't already done so, get the Instruction Manual and read it! Instruction or "Tech" Manuals are an invaluable asset to the technician. Study throughly the following pages in the NIDA 204 Instruction Manual. (You might be surprised at how much easier your Job Programs and PT's are).

Pages 2-20 through 2-23
pages 2-27 through 2-29
pages 2-30 through 2-32. (Table 2-1; Circuit Interface)
pages 3-2 through 3-5 (Table 3-1; Faulty Circuit Location Guide)
pages 3-6 through 3-12 (Troubleshooting Guide)

3. Remove the top cover of the NIDA 204 and insure all goods cards are installed.

   NOTE: DO NOT ENERGIZE THE NIDA 204.

4. Study Figure 5 of this job program and answer the following questions:

   (1) FREQUENCY SWITCH S2 is shown in the 10 KHz position. Will the astable multivibrator operate with the switch in this position? (Yes/No).

   (2) The astable multivibrator will operate with switch S2 in

   a. any position.
   b. any position except "1 Hz".
   c. the "10 KHz" position only.
   d. any position except "10 KHz".

   (3) Where should the CHANNEL 1 Probe be connected to?

   a. the input to the astable multivibrator.
   b. the output of the monostable multivibrator.
   c. the input to the monostable multivibrator.
   d. the output of the astable multivibrator.

5. Plug in and energize the NIDA 204 Function Generator.

6. With the CHANNEL 1 Probe, check signal at pin 10 P.C. 204-2 and record answer.

7. Check your answers to questions 5 (2) and 5 (3) by switching FREQUENCY SWITCH (S2) to its other position and checking for a square wave output with the oscilloscope. If the results of this check agree with your answers, continue to step 9. If your answers do not agree, go back to Figure 5 and study the action of the FREQUENCY SWITCH.

8. Ensure the FREQUENCY SWITCH is in the "10 KHz" postion. Determine the period and compute the output frequency of the astable multivibrator. Record your results. Period ____________ Frequency ________________.

9. Change the setting of the FREQUENCY DIAL (R21A and B) to "4" and answer the following questions:

   (1) The output frequency of the astable multivibrator

   a. increased.
   b. decreased.
   c. remains the same.

(2) When you changed the setting of the FREQUENCY DIAL, you changed the

a. capacitance of the RC circuit that determines the output frequency.
b. resistance of the RC circuit that determines the output frequency.
c. input frequency to the astable multivibrator.

10. The output of the astable multivibrator (PC 204-2, pin 10) connects to the input of the bistable multivibrator (PC 204-3, pin 3). The bistable multivibrator has two outputs: one at pin 8 and one at pin 11. Using Figure 5 answer the following questions:

(1) The output frequency of the bistable multivibrator is determined by the

a. RC time constants within the bistable multivibrator.
b. setting of switch S3.
c. input frequency to the bistable multivibrator.
d. setting of R22 (PULSE WIDTH DIAL).

(2) The output frequency of the bistable multivibrator is (twice/the same as/one half) the input frequency.

Set up the oscilloscope for dual trace operation. Using another 1X probe on Channel 2, compare the signal at pin 8 PC 204-3 with the Channel 1 signal on pin 10 PC 204-2. Compare your results with your answer in step 11(2).

(3) What is the relationship between the bistable multivibrator outputs (pins 8 and 11)?

a. The two outputs are identical.
b. Pin 8 output is twice the frequency of pin 11 output.
c. The outputs at pins 8 and 11 are equal in frequency but 180 degrees phase displaced.

11. Place Channel 1 probe on pin 11 PC 204-3 and Channel 2 probe on pin 8 PC 204-3. Compare your results with your answer to step 11(3).

NOTE: Ensure probe ground strap is not stretched or disconnected.

12. The third circuit used in this job program is the monostable multivibrator (PC 204-4). The components C1-4, CR1-4, R1-4 and R2-4 are not used. PULSE WIDTH switch (S3) and PULSE WIDTH dial (R22) are associated with the monostable multivibrator. Answer the following questions using Figure 5:

(1) The monostable multivibrator will generate an output pulse each time the input

a. changes polarity.
b. goes positive.
c. goes negative.
d. goes either positive or negative.

(2) The amount of time the monostable multivibrator will remain in its "unstable" state is determined by

a. RC time constant of the circuit.
b. input to the circuit.

(3) The amount of time the monostable multivibrator will remain in its stable state is determined by the

a. RC time constant of the circuit.
b. input to the circuit.

(4) With the PULSE WIDTH switch (S3) in the "10 μsec" position, capacitor __________ is in (series/parallel) with capacitor C3-4.

a. C13
b. C14
c. C16
d. C17

(5) With the PULSE WIDTH SWITCH (S3) in the "1 μsec" position, what capacitor(s) determine the pulse width?

a. C17 and C3-4
b. C15 and C3-4
c. C3-4 only
d. C13 and C3-4

(6) The PULSE WIDTH dial (R22) will control the (capacitance/resistance) of the RC time constant in the monostable multivibrator.

13. Place the Channel 1 probe on pin 2 (input) PC 204-4 and the Channel 2 probe on pin 9 (output) PC 204-4 and compare and verify the answers to question in step 13(1) through 13(6) by checking operation of the monostable multivibrator on your own.

NOTE: At the frequencies used in this job program the monostable multivibrator output will be unstable if the PULSE WIDTH switch (S3) is set to any position other than "1 µsec" or "10 µsec". In the "10 µsec" position, setting the PULSE WIDTH dial (R22), above "8" will probably result in unstable operation. This will not harm the equipment, but the output is unusable.

14. Before continuing with the job program let's review whay you have learned so far. First you learned that the astable multivibrator in the NIDA 204 will operate with the FREQUENCY switch (S2) in the "10 KHz" position only, and that the frequency can be varied with the FREQUENCY dial (R21A and B). The output of the astable multivibrator is the input signal to the bistable multivibrator.

The bistable multivibrator has two outputs that are 180 degrees phase displaced from each other. The output frequency of the bistable multivibrator is one-half the input frequency. Only one of the outputs from the bistable multivibrator is used in this job program. This output is taken from PC 204-3, pin 11, and is applied to the input of the monostable multivibrator. The monostable multivibrator will put a pulse at the frequency of the input. This output pulse will be of a duration determined by the setting of the PULSE WIDTH controls (S3 and R22).

15. Now go to Figure 5 and look at the FUNCTION switch (S4).

(1) With the switch in the position shown (square wave), where is the signal at the OUTPUT jack coming from (disregard the amplifier)?

a. PC 204-4, pin 12
b. PC 204-4, pin 9
c. PC 204-3, pin 11
d. PC 204-3, pin 8

(2) Where will the signal at the OUTPUT jack come from if the FUNCTION switch (S4) is placed in the " ⎍ " (pulse) position?

a. PC 204-4, pin 12
b. PC 204-4, pin 9
c. PC 204-3, pin 11
d. PC 204-3, pin 8

16. Place the oscilloscope in CHANNEL 1 mode and disconnect the 1X probe or CHANNEL 1 from the BNC "Tee" connector. Connect the OUTPUT jack of the NIDA 204 to CHANNEL 1 of the oscilloscope using a BNC - BNC cable.

17. Switch the FUNCTION switch back and forth between "pulse" and "square wave" positions. Note that the output changes from a pulse to a square wave.

(1) With the switch in the "pulse" position, the output signal is coming from

a. PC 204-2.
b. PC 204-3.
c. PC 204-4.

(2) With the switch in the "square wave" position, the output signal is coming from

a. PC 204-2
b. PC 204-3.
c. PC 204-4.

(3) If you have no output with the FUNCTION switch (S4) in the "pulse" mode, but you had an output in the "square wave" mode, which of the following would be the most likely problem area?

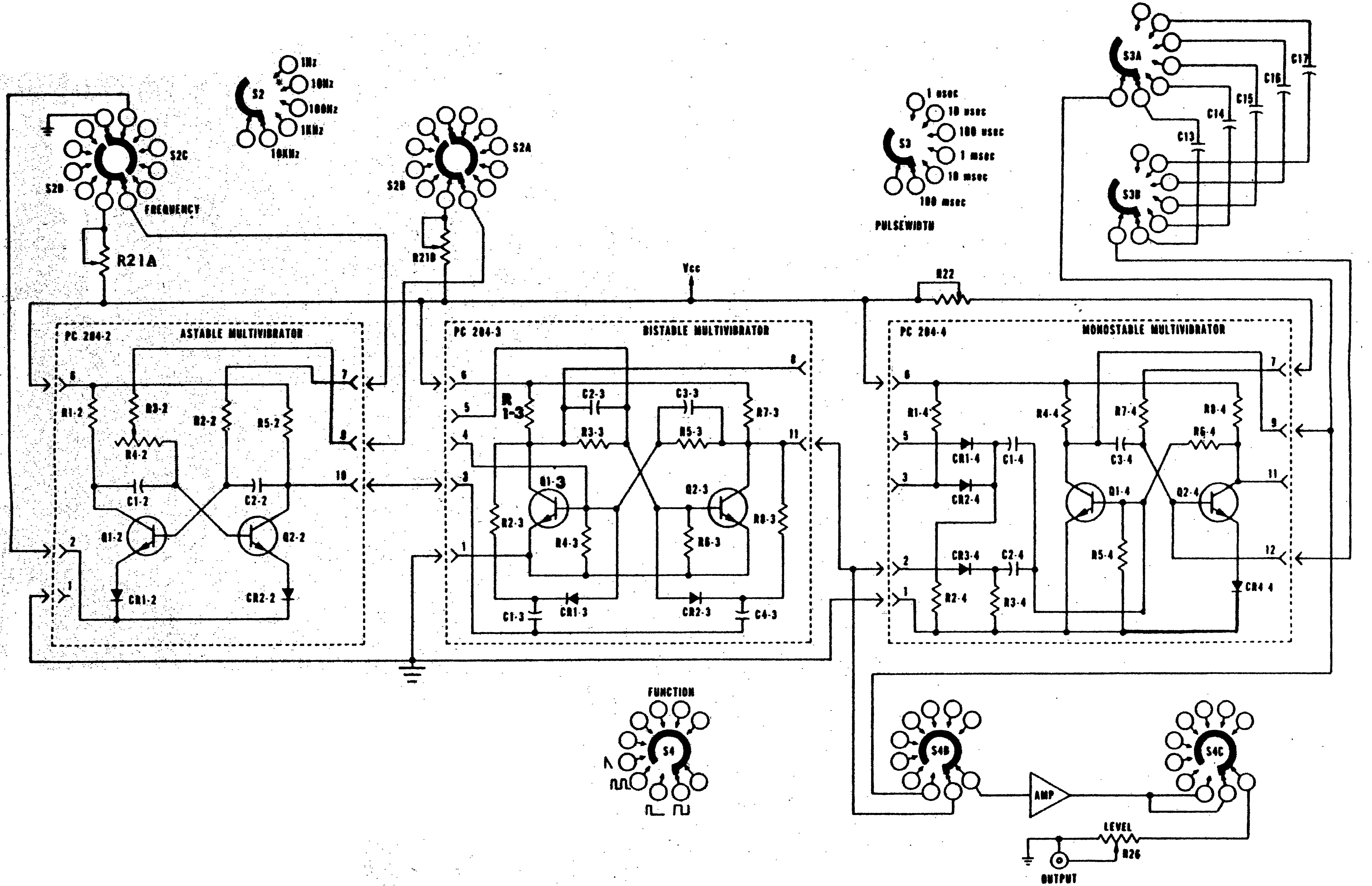
a. Switch S2.
b. PC 204-3.
c. PC 204-4.
d. Power supply.

Question 18 (3) shows a troubleshooting aid that is effective on many types of electronic equipment. Many times a casualty may be isolated to a specific area or even a circuit by using switches on the equipment to switch various sections in or out of operation. To use this aid requires a schematic drawing, block diagram, or other source of information to show what is happening when a certain switch is moved to a different position.

CHECK YOUR RESPONSES TO THIS JOB PROGRAM WITH THE ANSWER SHEET. IF YOUR RESPONSES AGREE WITH THE ANSWER SHEET, YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOUR RESPONSES DO NOT AGREE OR IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST OF THIS JOB PROGRAM, REVIEW THE PROCEDURES OF THIS JOB PROGRAM, ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS OR CONSULTATION WITH LEARNING CENTER INSTRUCTOR UNTIL YOUR RESPONSES DO AGREE.

18. Step 19 will not be performed until the Progress test has been satisfactorily completed. Upon completion of Progress test return to Equipment Lab and complete this job program.

19. Now that you have completed the Progress test, see your Learning : Instructor and obtain Equipment and Materials to troubleshoot ılted P.C. 204-2, 204-3, and 204-4 cards to the faulty component. ou feel you have located the problem, check with your Learning Instructor to see if you are correct in your analysis. After ion of the troubleshooting portion of this Job Program, proceed performance test.



SQUARE WAVE & PULSE MODE

FIGURE 5

PROGRESS CHECK
LESSON III

Monostable Multivibrators

1. The monostable multivibrator has ______________ input(s).

USE THE BELOW ILLUSTRATION FOR QUESTIONS AS INDICATED.

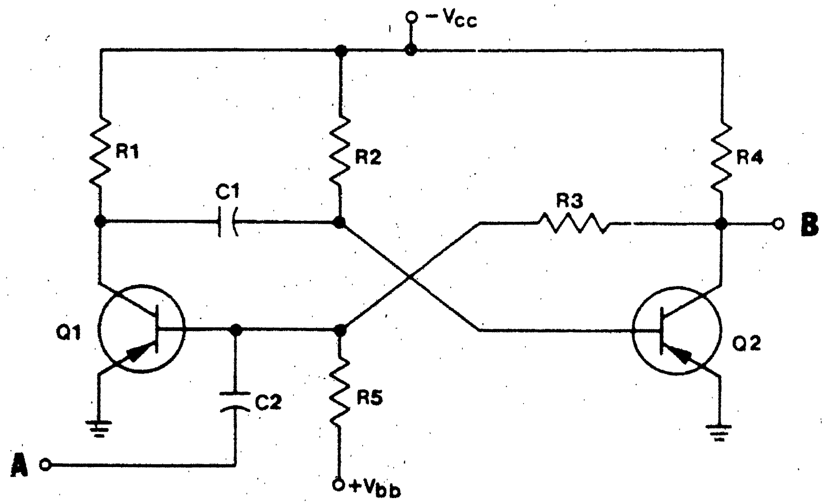


Figure 1

2. Before a trigger is applied to the circuit in figure 1, Q1 will be (cut off/saturated) and Q2 will be (cut off/saturated).

3. To change the state of the circuit in figure 1, a ______________ pulse would be applied at the input.

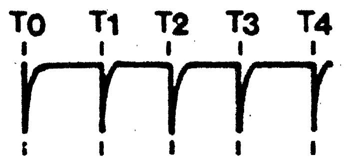
4. The monostable multivibrator returns to its stable state after a (definite/indefinite) period of time.

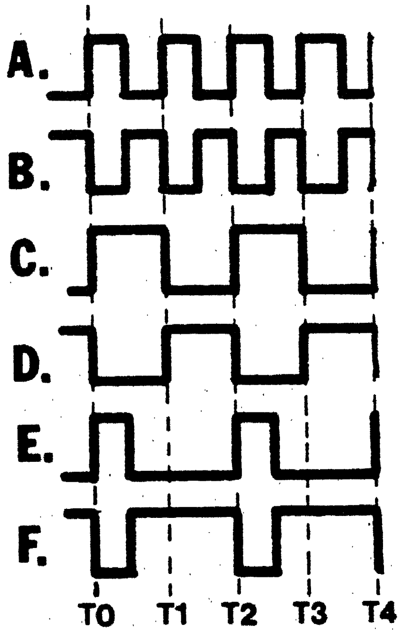
5. In figure 1, point A is the (input/output) and point B is the (input/output).

6. In figure 1, when Q1 is saturated the output will ______________.

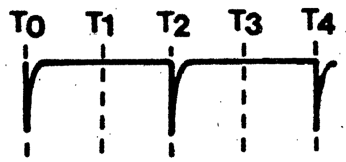
In questions 7 and 8 match the input triggers shown with the output wave forms. (Use the circuit represented in Fig. 1).

7.





8,



9. Refer to figure 1. The time duration of the negative output pulse is determined by

a. C2 and R2.
b. R1 and C1.
c. C1 and R2.
d. R1 and C2.

Match the circuits following question 15 with their correct titles for questions 10 through 15.

10. Flip-flop multivibrator _____

11. Monostable multivibrator _____

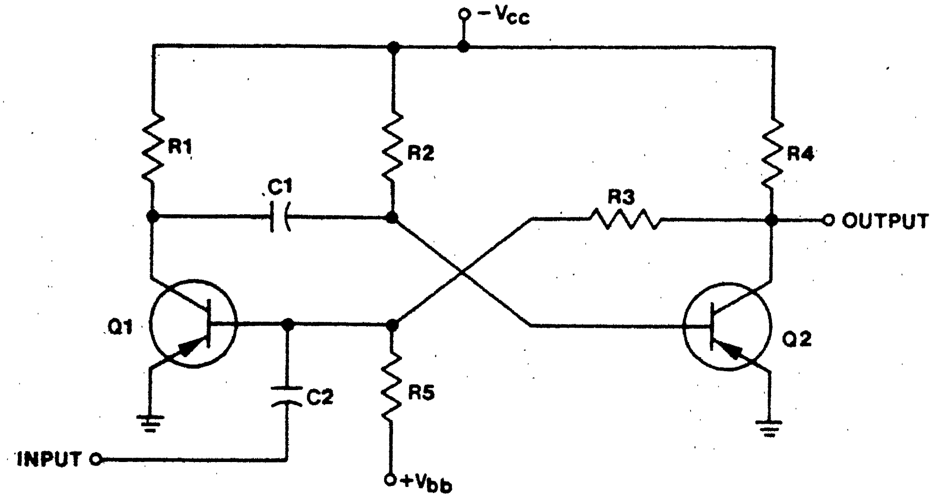
12. Astable multivibrator _____

13. Bistable multivibrator _____

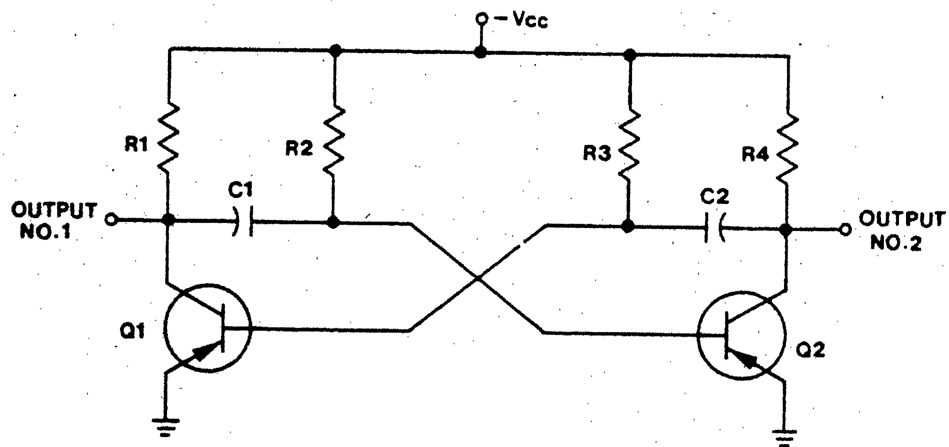
14. One-shot multivibrator _____

15. Free running multivibrator _____

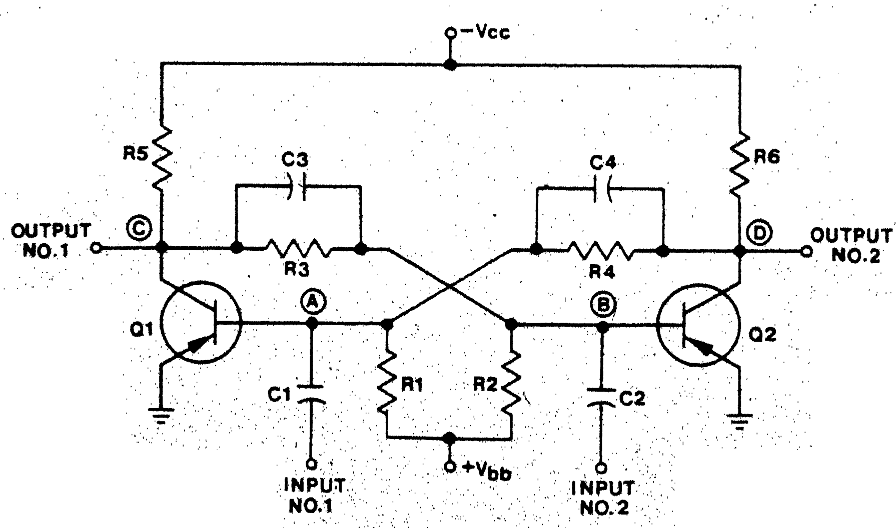
a.


-Vcc
R1
R2
R4
C1
R3
OUTPUT
Q1
Q2
C2
R5
INPUT
+Vbb

b.


-Vcc
R1
R2
R3
R4
C1
C2
OUTPUT NO.1
OUTPUT NO.2
Q1
Q2

c.


-Vcc
R5
R6
C3
C4
OUTPUT NO.1
C
R3
R4
D
OUTPUT NO.2
Q1
A
B
Q2
C1
R1
R2
C2
INPUT NO.1
+Vbb
INPUT NO.2

16. When the circuit shown in figure C on the previous page is energized

a. Q1 only will saturate.
b. Q2 only will saturate.
c. Q1 or Q2 will saturate.
d. Q1 and Q2 will saturate.

17. When circuit B illustrated on the previous page is energized

a. Q1 or Q2 will saturate and remain saturated.
b. Q1 will cut off.
c. Q1 and Q2 will alternately saturate and cut off.
d. a sawtooth waveform will appear on output 2.

18. When circuit A illustrated on the previous page is energized

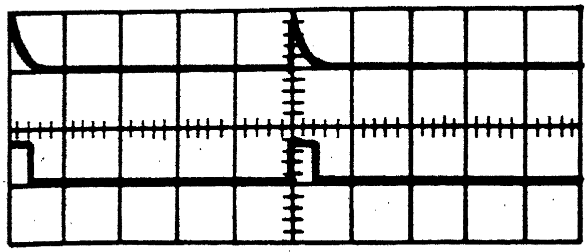
a. Q1 will saturate and remain saturated until triggered.
b. Q2 will saturate and remain saturated until triggered.
c. it is impossible to tell which transistor will saturate first.
d. neither Q1 or Q2 will saturate.

CHECK YOUR ANSWERS TO THIS PROGRESS CHECK WITH THE ANSWERS IN THE BACK OF YOUR STUDENT HANDOUT. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ANY PART OF THIS LESSON YOU SHOULD CONSULT YOUR LEARNING CENTER INSTRUCTOR FOR ASSISTANCE AND REMEDIATION. IF YOU ANSWERED ALL QUESTIONS IN THE PROGRESS CHECK CORRECTLY, CONSULT YOUR LCI FOR ASSIGNMENT TO THE MODULE TEST.

ANSWER SHEET
FOR
JOB PROGRAM
LESSON III

Monostable Multivibrator (One Shot)

6.



7. less than

8.* 930 microsec ± 5%

9.* 50 microsec ± 10%

10. c

11. b

12. c

13.* 200 microsec ± 10%

14. increased

* These values represent the average readings of numerous equipments

ANSWER SHEET FOR JOB PROGRAM LESSON III PART 2

4.

(1) YES

(2) c.

(3) d.

8. Period <u>37 usec</u>, Frequency <u>27 KHz</u>. (± 10%).

9.

(1) a.

(2) b.

10.

(1) c.

(2) one-half.

(3) c.

12.

(1) b.

(2) a.

(3) b.

(4) d, parallel

(5) c.

(6) <u>Resistance</u>.

15.

(1) c.

(2) b.

17.

(1) c.

(2) b.

(3) c.

ANSWER SHEET
FOR
PROGRESS CHECK
LESSON III

Monostable Multivibrator Operation (One Shot)

QUESTION NO.	CORRECT ANSWER
1.	one
2.	cut off, saturated(in that order)
3.	negative
4.	definite
5.	input,output(in that order)
6.	be-Vcc
7.	b.
8.	f.
9.	c.
10.	c.
11.	a.
12.	b.
13.	c.
14.	a.
15.	b.
16.	c.
17.	c.
18.	b.